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ELEMENTARY SCIENCE TEACHING IN THE LABORATORY SCHOOL.

I.

IN any general discussion of the place of science in elementary education it is hardly necessary to state that the evidence gathered from publications, as well as from incidental observation, seems to indicate a general dissatisfaction with the results of the nature-study attempted during the past ten years. In general the criticisms take the same forms as those upon the results of manual training; the reason often given for this lack of success is practically the same in both cases. Both nature-study and manual training have been additions to the curriculum, and the explanation of their failure lies in the word "additions." This mysterious and undefined nature-study has been generally inserted by the powers that be in an already crowded course of study. But perhaps the more fundamental objection to the kind of work put in as elementary science, or nature-study, lies in the fact that here, more than in any other subject, the special training and experience of the teacher count in obtaining the result. By this is meant, not simply technical and special training in any of the sciences, but the possession by the teacher of what might be called limiting general concepts; first, scientific method in itself; second, a sympathetic understanding of the springs of action of the child, united with knowledge of the content of the different sciences. It might be objected that a demand for the possession by the teacher of such generalizations would incur the danger of crudity, and the exact reverse

of the result hoped for, namely, attainment in the end of a scientific attitude on the part of the child. This is no more than we ask ethically when we demand character on the part of the teacher. Character as a force in the education of children demands some conception on the part of the teacher of the ideals toward which he is working. Similarly, the presence of general scientific ideas or concepts in the teacher's mind ought to enable him to pick out typical points in the child's experience, and to give that experience such form that the child gradually approaches the scientific ideal through his own initiative and originality, directed, but not limited, by the ideal in his instructor's mind. Our salvation in science-teaching lies in the fact that, if the method of approach in one line be truly scientific, it will give the clue to the method to be used in any other. One essential thing to be insisted upon is the teacher's ability to recognize the purpose of hypothesis or theory, as merely outlining present knowledge and to be held always flexible, ready for readjustment, or even abandonment, whichever should be demanded by scientific growth and development.

This newer psychological principle of the unity to be found only in experience, in activity, clears the dead wood of inheritance from the field of education in much the same way that in physiology the recognition of the part physical and chemical forces play in living matter has revolutionized that field. The possibilities of control thus opened up are perhaps more easily grasped, but not one whit less revolutionary and encouraging, though baffling, than the very similar opportunities afforded by the clearing and extension of the paths of education by the later psychology. It is certainly true that in the past general scientific principles have guided the selection of subject-matter, but though this has sometimes involved an unconscious recognition of activity on the part of the child, thus making these attempts more or less successful — more successful as the activity chanced to gain ground, less so when scientific conventions ruled — nowhere do we find conscious recognition of this activity as a true motive underlying the choice of subject-matter.

Taken from a point of view of the children's interest and activity, certain main reasons for giving elementary science a place are so apparent that they can almost be taken for granted. First, children show natural interest in observation and experiment. This experimentation is, of course, only one of the child's activities going on almost unheeded and constantly, unless checked by artificial conditions. That these limiting conditions exist in most children's lives is very apparent. That children have consequently lost this active interest in objects and phenomena is a common observation. Even granting, however, deficiency in the technical training on the part of the teacher, something more is necessary to explain the dulled observation and lack of interest found in children of from twelve to fourteen years. For some years the following questions have been asked by teachers in the secondary schools and in the university: Why has the nature-study of the lower schools not counted for more, as furnishing both data and methods of observation and experiment? Why is it that so often we find absolute incapacity to see or to formulate accurately the simplest observation? Granted the premise, as stated above, that the child possess an experimental attitude toward, and an active interest in, natural objects and phenomena, it follows as a necessary corollary that the right treatment of this attitude would preserve these natural interests. The problem, as it now stands, is to discover the form which this general interest takes at different stages of the child's development, and how this natural and spontaneous experimentation can be profitably used as a basis for later scientific work involving conscious abstract formulation.

In solving this problem, the first question to be answered is what suggestions as to method and subject-matter are furnished by the spontaneous interests of children at various ages.

In a cursory examination of the articles on this subject published in the various periodicals conducted by teachers themselves, and by scientists and educators interested in the problem from a theoretical point of view, the methods which have been used may be found classified into four schools. As there are many courses of study which are not included in any of the four

groups described, this classification, it must be understood, is a very rough and general one. First, and apparently the most generally used, is the one described by Mr. Hodge[1] as the knot-hole method. Incidental material called nature-study is used as a basis for all forms of expression work. This material is chosen from the teacher's point of view, largely with the idea of correlating the child's outside life and school life. The method seems to be that used in so-called object-lessons of any kind — chiefly description by child or teacher, with some attempt at classification and the loading in of any bits of information which arrest the child's attention. As a result the subject-matter material is unrelated, and to a great extent dependent upon accidental incidents in the child's or teacher's experience. The method of using this subject-matter is either not defined or else not adapted to the period of the child's development. The best organization of material on this basis is found in Cornell University "Nature Study Leaflet Series." In this classification might be included the attempt on the part of scientists and teachers to select bits of the child's physical environment and to systematize them with some regard to the child's interest as affected by the seasonal changes. As an illustration of the effect of such a point of view might be quoted the remark of a very intelligent teacher who was about to undertake work in a country where there were no such marked seasonal changes as occur here. "I do not see," she said, "what I can do in children's nature work when I have no changes of season to afford occasion for it." In a few cases we find in this incidental use of physical environment an individual teacher insisting upon the fact that a child's activities are a necessary factor in the choice of material. In such instances, therefore, there will be a greater amount of experimentation on the part of the child than is generally found in nature-study conducted on this basis.

The characteristic phrase of the second school is "the organization of the child's world of nature"— with much stress on the child as the focal point — while the organization is all from the adult's point of view. The ideal seems to be a scientific inter-

[1] *Pedagogical Seminar*, Vol. VI.

pretation of the landscape. To quote Mr. Hodges on this point: "All the earth and all sciences are cut up into sections, and are given out in small slices each year, as suited to the child's comprehension, with special emphasis on technique." The progressive step taken by this school seems to be an attempt at organization of material, but it is a question whether this organization proceeds from the teacher or the child. Might not the ideal be stated as power to be gained through observation, accompanied, or followed at a respectful distance, by inductive reasoning? General truths are laid down as propositions to be proved, or in the forms of questions to be answered. Are these questions the child's or the teacher's? If necessarily the teacher's, is there any application by the child of the proposition proved or the question answered? The final aim seems to be the realization by the child that he is the focus of innumerable forces so bearing upon him that the knowledge of how they can be controlled shall appear to him as a necessity. The statement is made that the child's life is the center, but it seems to play too much the part of a mere focus of forces without taking into consideration the child's choice in reaction to these forces. Does not this method ignore the fact that the child's power to use his abstraction is a test of his actually forming it for himself? Does it not take for granted a universal interest on the part of the child, that, as all things touch him, they therefore interest him?

A third school might be called the Agassiz school. This starts with the organization of scientific material from the adult scientific standpoint. Here the child's interest is unconsciously taken for granted by the teacher, from past experience. It might be suggested, however, that the formal nature of the other subjects in the curriculum, where the child's activity is not largely called into play, has made it possible thus to assume from experience this interest in nature-study where activity finds opportunity. We find successfully given a series of lessons, say in elementary physics, all planned so as to demonstrate two or three general principles. The same absorbed interest in formulation or abstraction is demanded from the children as that used by a scientist in investigating his particular subject. Machines and the use of

familiar forces concerned are skilfully interspersed, but the motive is assumed to be the end, that is, the formulation of laws and principles. On the biological side the same attitude might be illustrated by a series of monographs on the various forms of animal life, where detailed attention is given to morphology, with only an incidental line or two on modes of life, habit, or functions.

Perhaps the most salient point is the general insistence on the value of inductive reasoning.

The most recent of these schools is that which claims the title "evolutionary." As a result of investigations into children's activities, conducted largely by untrained observers using the questionnaire method, certain general conclusions as to the nature of children's interests are drawn. The child's interest in natural phenomena is due largely to the personal imaginative element. Animism is the placenta by which the love of nature is nourished, and stimulated to grow toward its maturity—scientific interest. Here we find the statement that the whole of nature is adapted to the child's understanding, and that all natural objects and phenomena, studied in their natural relations or settings, constitute actual nature-study. The two sources of knowledge seem to be as follows: development of man's relation to nature in the past, and study of the spontaneous interests of children; while, as a third and minor point, a necessary understanding of the psychological laws, as indicated in the quality of knowledge and nature of interest in general, is suggested. In taking Dr. Hodge as an illustration of this school, we find that he states his method as following the development of the race. But in his indications of how he would apply this study of race-development he seems to leave out men themselves. He insists on the educational value of domestic animals. He has gained from experience sympathy with children which makes him urge the value of the relations established through a child's care for his garden and animals, but suggests no use of the evolution of man himself as furnishing material for the direction of the activities of the developing child.

He appreciates the value of a knowledge concerning the eco-

nomic relation of man to nature in many particular instances, such as that gained from the study of injurious and helpful insects and animals, but suggests no use of the experimental attitude as leading to further control through a scientific understanding of forces involved.

In an article by Professor Dolbear on the place of science in education is found a very clear statement of the necessity of a scientific study of the child himself, with the object of ascertaining just what race-habits of thought tend to survive in the present. This insistence, however, is largely enforced by statements on the negative side. He insists that the ideal of education in the past has been to attain by repression of race-instinct an entity called "mind," which, according to the teacher's idea, has seemed to be a machine calculated to take certain facts given and to react upon them in accordance with a pre-established order. His positive suggestions relate to the indications furnished by modern physiology, that the wisest course in modern education is that which involves the least prescription and rigidity of work and the greatest amount of expression with guidance. He insists that the connection between the use and growth of the mind, as indicated by neurological research, has been misinterpreted by those who thought they were applying the principles.

The suggestions in my next article, as to what changes or modifications of the above points of view can be furnished by a consideration of the problem as involving the application of psychological law on the side of an understanding of the child, guided by general conceptions of the content of the various sciences in the selection of particular subject-matter, are, from the nature of things, individual and tentative, and should be so; but the general principles, those from which every experience must work, remain the same.

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[*To be continued.*]